Able to Read My Mail: An Accessible e-Mail Client with Assistive Technology

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ABSTRACT

The Able to Include project aims at improving the living conditions of people with intellectual or developmental disabilities (IDD) in key areas of society. One of its focus points concerns improving the integration of people with IDD in the workplace by introducing accessible Web-based tools. This paper describes one of the tools developed as result of the project: an e-mail client with text simplification and other assistive technologies which makes information transmitted over the Internet more understandable to people with IDD therefore facilitating their labor integration. The accessible Web e-mail client has been developed following a User-Centered Design and tested with people with IDD. The results so far are encouraging.

CCS Concepts

•**Information systems** → **Internet communications tools;** •**Human-centered computing** → **Accessibility technologies;** *Interaction techniques;*

Keywords

Electronic Mail, Independence at Work, Disabilities and Accessibility, Automatic Text Simplification, User-centered Design, Text-To-Pictograph Translation

1. INTRODUCTION

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The inclusion of people with disabilities into the workplace is a human right shaped in Article 27 of the United Nations convention for the Rights of People with Disabilities. Although in recent years modern societies have made good efforts to improve the working conditions for people with physical or sensory impairment, barriers still exist for people with intellectual or developmental disabilities (IDD) where the digital workplace and the Web are concerned: for example, many computer tools and software programs to access information on the Web, which are used at the workplace, are designed for a "generic user" leaving IDD people marginalized from their functionality and therefore from the right to progress in the workplace. The *Able To Include* project is working towards including people with IDD in the digital world by producing software specially adapted in three key areas of society: independent mobility, social networking, and labor.

One key development of *Able to Include* is an Accessibility Layer [8], a set of integrated services to create a context-aware assistive technology which developers will be able to call from their applications in order to make them more accessible. The layer is delivering language specific functionality such as text-to-speech in several languages, text simplification in Spanish and English, and text-to-pictograph translation in Spanish, English, and Dutch.

In this paper we report on our work so far in the development of a key tool for Web information access which uses the accessibility layer: an accessible e-mail – an essential tool for labor and social integration. The development of the e-mail client is carried out by (language) technologists in collaboration with teachers, caregivers and end users from the Prodis foundation.[1]

Complicated design of generic e-mail programs (e.g. menus, tabs, buttons, too many functions) is by no means the only problem for people with IDD: one of the most important features of e-mail programs is to transmit and receive *text messages* which represent a further accessibility barrier. People

[1] www.fundacionprodis.org

with IDD may require texts messages to be written in an *easy-to-read* language with short sentences and common vocabulary, which may be difficult or unnatural to write by the sender. A solution to this problem is to allow messages to be naturally written and automatically simplified only upon the receiver's request. Although there are a number of commercial e-mail programs (mainly for the elderly) and some research in the area of e-mail communication for people with cognitive disabilities (cf. section 2.1), to the best of our knowledge there has been no previous research or technological developments in the area of e-mail and text simplification technology. Therefore, the e-mail tool reported in this paper is the first to address Web text accessibility in the context of e-mail mediated communication.

2. RELATED WORK

Previous research related to our work can be structured in (i) accessible e-mail clients, (ii) automatic text simplification tools, and (iii) text to pictograph translation.

2.1 Accessible Mail Clients

Sohlberg et al. [15] cites a number of problems that people with disabilities have with "universally designed" email programs from the fact that their features are difficult to learn and remember or their interfaces contain too many distracting options, to the fact that they can be unsafe and difficult to use.

Sohlberg et al. [11] carried out an exploratory study to understand preferences of people with cognitive and linguistic impairments where e-mail composition interfaces are concerned. Four different e-mail composition interfaces were tested from a conventional composition window (to enter free text) to a highly structured multiple-choice message input console to interactively compose the message. While no clear preference emerged from the study, a clear enthusiasm for being able to send messages by email was observed in the participants studied. In a follow-up study the *Think and Link* e-mail program (now *CogLink*) was specially designed [16]. The tool features icons to represent addressees, a simplified interface with large fonts, adjustable color and contrast, split screens, and prompts tailored to the user's needs.

Most accessible e-mails have been developed for elderly users; *Eldy*, for example, is a Web-based platform specially designed for elderly citizens which features basic yet essential functionality including an easy-to-use e-mail program [1]. Most research in accessible e-mail programs has concentrated on usability rather than on understanding the text messages received.

2.2 Automatic Text Simplification

Automatic text simplification is a research field in Computational Linguistics which studies methods and techniques to simplify textual content [13]. Text simplification methods should facilitate or at least speed up the adaptation of available and future *textual* material, making accessible information *for all* a reality. Although there are many text characteristics which can be modified in order to make a text more readable or understandable, including the way in which the text is presented, automatic text simplification has usually concentrated on two different tasks: *lexical simplification* [2] concerned with the replacement of words and phrases by simpler equivalents, and *syntactic simplification* [3] concerned with reducing the length and syntactic complexity of sentences.

Lexical simplification has usually required access to a lexical resource or thesaurus for synonyms, it was first addressed in the PSET project [5] where WordNet [10] provided synonyms for complex words and a Psycholinguistics Database [12] provided information on word complexity. Early syntactic simplification systems were based on pattern-matching approaches in which hand-crafted re-rewriting rules identified complex linguistic constructions in sentences (e.g. relative clauses, apposition) and provided information on how to transform them into simpler equivalents. Current text simplification research is based on more empirical research, casting simplification as a statistical machine translation problem (e.g. translating from complex to easy language) [4, 18]. These methods, which are at most able to model very simplistic syntactic transformation, fail to model complex transformations which may be necessary for specific target populations such as people with IDD [13].

2.3 Text To Pictograph Translation

Pictograph communication has grown from local initiatives, some of which have scaled up to larger communities. Systems that automatically augment written text with pictographs for people with reading difficulties are primarily conceived to improve the comprehension of textual content. However, they are sparse. As noted by Vandeghinste et al. [17], currently available systems provide no or only a very limited amount of linguistic knowledge in order to appropriately disambiguate lexical ambiguities, which can lead to wrong conversions into pictographs or to the conversion into multiple pictographs per word, one for each sense of the word. An application of the latter can be seen on `www.widgit.com`.

Mihalcea and Leong [9] evaluate the hypothesis that pictorial representations can be used to effectively convey simple sentences across language barriers and to enable communication to and from preliterate or non-literate people, or language understanding for people with language disorders. The PicNet database relies on a web-based system for augmenting dictionaries with illustrative images using volunteer contributions. The system takes a sentence as input and first applies tokenisation and lemmatisation. The most likely meaning for each word is derived using a publicly available sense tagger.

Joshi et al. [7] describe an unsupervised approach for automatically adding pictures to a story. They extract semantic keywords from a story to search an annotated image database, but they do not try to translate the entire story.

These systems were not developed with users with IDD in mind.

3. KOLUMBA: AN ACCESSIBLE E-MAIL CLIENT FOR PEOPLE WITH IDD

The e-mail client was designed from start following a user-centred approach involving technologists, disability professionals, careers, and people with IDD. These sessions were leaded by professionals of Ariadna Servicios Informaticos SL, the initial coordinator of the *Able to Include* project. Ariadna shared the expertise in user-centered design to identify the needs of the IDD user towards their integration in the labour environment. In the working sessions, the digital-

isation of companies was identified as a relevant problem: IDD users are very familiar with physical email and document management but new tools and services are not always adapted for them. Several proposal arised and, finally, the concept of Kolumba was born.

3.1 Technical Details

Kolumba is a web-based email client adapted for people with intellectual and developmental disabilities (IDDs) and specially designed to help their interaction with the information society. Wireframes were prepared and validated by Fundación Prodis professionals. After the creation of a first version, it was improved through discussion groups of people with IDD and direct care professionals in order to adapt the tool to their preferences or needs as much as possible. These changes were later implemented by the technologists. Kolumba has a very easy interface that allows the basic email functions of sending, receiving and deleting emails and manage contacts. Furthermore it has access to the Able to Include Accessibility Layer [8] that allows the use of the following three advanced Natural Language Processing (NLP) technologies for English and Spanish: Textual simplification, Textual conversion to pictograms and Text to speech. The Textual simplification option provides the functionality of simplifying lexically and syntactically the incoming emails to be more understandable by readers. The Textual Simplification architectures used are the Simplext (for Spanish) [13] and YATS (for English) [6]. The Text-to-Pictograph translation option allows to translate text into pictograms to help people with difficulties to understand natural language. The texts can be translated to Sclera[2] or Beta[3] pictographs through the Text-to-Pictograph translation tool [17, 14]. The Text-to-Speech tool converts the text to audio speech in order to help people with reading difficulties. The eSpeak[4] speech synthesizer has been used for Text-to-Speech conversion. Kolumba has been developed as a web application that uses the google gmail API to perform the basic email functions. This means that Kolumba users have to own a google gmail account. The code of Kolumba is open source and has been developed with the PHP and HTML programming languages. Kolumba offers high information accessibility to people with IDDs through compatibility with both computing devices (computers, tablets, smart-phone,...) connected to Internet and major web-browsers; enabling them to use it in their personal life and working activities.

3.2 The Natural Language Processing Services

In a nutshell, the state-of-the-art **text simplification system** implemented in the *Able to Include* Accessibility Layer performs lexical simplification with a pipeline of natural language processing component using a lexical database of word senses and synonyms. The program identifies complex words, substitutes them by simpler synonyms (after a robust process of word sense disambiguation), and appropriately inflects the chosen synonyms taking into account morphological features (morphological generation). The syntactic simplification process is a pattern-matching and transformation program which uses a set of grammars to identify and transform long and complicated sentences into simpler

[2]http://www.sclera.be
[3]https://www.betasymbols.coml
[4]http://espeak.sourceforge.net

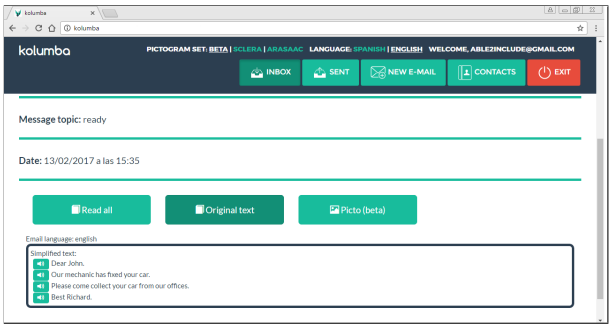

Figure 1: Kolumba Received Message Simplified

equivalents. The syntactic simplification system operates on dependency-parsed trees. The advantage of our text simplifier is that can be easily customized to cover additional languages.

As an illustration of the text simplification functionality integrated into Kolumba, we show in Figure 1 a text message opened in the Kolumba interface and simplified by the simplification service. The message is displayed with buttons which allow the user to listen to the message. In this particular case, the text:

> *Dear John. Your automobile has been repaired by our mechanic. Please come collect your automobile from our offices.*

was translated into the easier to read version:

> *Dear John. Our mechanic has fixed your car. Please come collect your car from our offices.*

As it can be noticed, several transformations took place: (i) a sentence in the passive voice (*has been repaired*) was transformed into active (*has fixed*), and (ii) several lexical transformations (e.g. *repair* into *fix*, *automobile* into *car*) were applied.

The **Text-to-Pictograph** translation tool automatically converts the text into a series of pictographs. It does this by first applying shallow linguistic analysis, i.e., tokenization, spelling correction, part-of-speech tagging, and lemmatization. It then finds an optimal pictograph sequence by consulting a pictographically annotated WordNet database. Pictographs are connected to synsets or groups of synonymous words, allowing the pictograph translation engine to make use of all sorts of semantic relations. For example, if no pictograph exists for a specific concept, the more general concept can be used. An example of Text-to-Pictograph translation is given in Figure 2.

Figure 2: Text-to-Pictograph translation for *come get your car*

4. VALIDATION

A total of 30 items related to Kolumba were validated (62 IDD users) by means of questionnaires (answers in a 5-point Likert scale). The evaluated items included questions about easiness of operation (*Opening a mail message is easy*, *I have doubts about how to use Kolumba*, *I know what to do with the mail*), readability of the text (*I understood the text*), understanding of the pictograms (*I understand what the pictograms/pictures mean*), or understanding the spoken message (*I understand what the voice says*). With respect to the feedback received for the easy-to-read texts, some problems have to do with wrong choice of synonyms which we improved by excluding hypernyms from the dictionary and by improving the word-sense disambiguation system by training with a much bigger corpus (e.g. Wikipedia). Where the pictogram translation is concerned, the system is improved by updating the pictogram database and linking new pictograms to the dictionary. With respect to the spoken messages, one of the main critics was the unnatural voice of the text-to-speech system in Spanish, which we have already changed.

5. CURRENT DEVELOPMENTS AND FUTURE WORK

Our current digital world has many non-physical barriers which hinder the integration of people with IDD into the workplace; one of these barriers is the information transmitted through the network which is in most cases difficult to understand by people with disabilities. In this paper, we have presented our work in progress towards the development of an e-mail client with assistive technology which allows people with IDD to access e-mail messages using text simplification, text-to-pictographs, and speech technologies. The e-mail application makes use of a context-aware accessibility layer which is easy to integrate into accessible software. The e-mail client in under the third cycle of testing with people with IDD and their carers who are very positive about the integration of such tool in the workplace. The user evaluation of the assistive technology is providing the necessary feedback to tune the text simplifier and translation tools in aspects related to the improvement of the dictionaries or the morphological generation component. The technology presented in this paper could also be used, with appropriate tuning, to cover the needs of non-IDD users such as elderly people or people with dyslexia which may benefit from simplification technology. Our technology can easily be adapted to cover additional languages.

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